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ABSTRACT

Experiments were devised to determine teacher effectiveness on the basis of ability to communicate, on the assumption that no relevant learning will occur if communication is faulty. A series of communication games involved an encoder (teacher) and decoder (student) to provide tentative answers to the questions: 1) Are there individual differences in encoding abilities? 2) On what dimensions do the messages generated vary? 3) How do variations in encoding influence decodability? 4) What is the effect of feedback from the decoder? Two groups of materials were used, a wooden board with holes holding forms of different shape, color, and size and a crayon, cup, coin, box, pencil, and scissors. Results suggested that: 1) Adults differ substantially in their effectiveness in encoding even simple messages. 2) Intellectual development is important in preparing an informationally adequate message. 3) There is a limit to the amount of information a child can retain and instructions must be broken into appropriate lengths if they are to be successfully handled. 4) The percentage of correct results will increase when the objects are visible during the period of instruction. 5) If information is transmitted more slowly, it will be more correctly interpreted. Two further studies are in progress to test the effects of feedback and to identify independent variables to account for success in communication. [Not available in hard copy due to marginal legibility of original document.] (MBM)

The Teacher as Communicator: An Aspect of Teacher Effectiveness

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Two parallel concerns in education involve understanding the characteristics of an effective teacher and the nature of teacher training that could lead to the development of these characteristics. While this question looks simple and accessible on the surface, it has led to little systematic evidence or theory that specifies the relationship between the teacher and the teaching process. For about 40 years educational researchers sought a list of personality traits that could be linked with teaching effectiveness but with little success. The assumption was usually made that the experimenter had included the wrong list of traits or that the criteria for evaluation were faulty in some way. For example, Anderson and Hunka (1963) after surveying the lack of productivity in this area hypothesize that the failure to understand effectiveness is attributable to the personal bias of the observers. While there is some merit to this suggestion, it appears likely that even with objective raters, the measuring of teacher effectiveness would be poor, because raters do not know what to look for. Do you rate whether the teacher sits or stands? if he smiles a lot? gestures? uses the blackboard? The list is indefinitely extensible. Unless you know what to look for, the probability is negligible that you will observe the right things by chance.

The question remains, what does one look for in attempting to understand effective teaching? A virtually unexamined, and potentially important perspective is from the point of view of the communication process. From this perspective, the teacher, as an encoder, has the responsibility of so encoding a message as to be decodable by the listeners. It is obvious that this decoding may fail to occur for any of several reasons. All of the information may not be in the message. The information may be there, as far as some objective criterion is concerned, but the encoder may fail to take into account the specific informational requirements of the decoder through ignoring his age, background, or frame of reference. If the encoded message is faulty in any of these aspects, no relevant learning can occur.

This perspective has an obvious correspondence to the heart of the instructional process in that it focuses on the specific teaching act and not on the related or instrumental aspects of teaching such as the friendliness or firmness of the teacher. Hunt (1967) and Hunt and Joyce (1966) have begun a series of studies that relate to this communication function. They have shown that the conceptual level or degree of abstractness of a teacher is related to his ability to "radiate a wide variety of environments". For example, they found that in a communication task there was a great variability in the degree to which teacher trainees could take the learner's frame of reference into account. Those teachers who could adapt their messages to the frame of reference of the listener were also judged, on an independent basis, as more effective teachers. Gage (1967) has also initiated some studies on "micro-teaching" that show some promise of differentiating good from poor teachers. The limitation of both of these approaches is that no actual measure of the content or interpretability of the messages is possible.

If the communication act is a crucial one, it remains to develop a satisfactory means by which this process can be examined and described. Recent scientific developments may be combined to provide this means. The first comes from information theory which provides a conceptual framework for analyzing the content of messages and the second comes from the experimental techniques of communication games as they have been used to study the development of social communication in children.

The communication games generally involve two persons, an encoder and a decoder, who are separated from each other by a screen; the requirement is that the encoder so describe a pattern or an object that the decoder can select this pattern or object from a set of alternatives.

This task has been used to study the development of social communication in children (Cowan, 1967; Glucksberg and Klauss, 1967), the effect of frequency of usage on the reference phrase (Krauss and Weinheimer, 1964), and the effects of practice on communication skills (Fry, 1966). The tasks may be easily modified and extended for use in studying the teacher-child communication process.

The use of this experimental technique together with the conceptual model of information theory permits the empirical study of the encoding process and the decoding process independently as well as their interaction.

This first set of experiments was directed to providing tentative answers to the following questions:

1. Are there individual differences in encoding abilities or strategies?
2. On what dimensions do the messages generated vary?
3. How do these variations in the encoding influence the decodability of the messages?
4. What is the effect of feedback from the decoder on the communication process?

Method

Materials: A six inch wooden form board with four round recessed holes ($d = 2"$) each of which held a wooden form was the subject of the encoder's descriptions as well as the decoder's constructions. The forms varied on four binary dimensions:

shape - circle or triangle

size - large ($d = 1\frac{1}{4}"$), small ($d = 3/4"$)

color - black, or white

design- a star or arrow was on each form.

Messages could therefore take the form of: "Put the small white triangle with the arrow on it, into the top, left hole of the board." The message, therefore, contained six bits of information.

Encoding experiments: In two pilot experiments, Ss were shown a pattern of forms arranged in one form board and they were asked to describe the pattern on their board such that another child who was listening could build a pattern identical to it on his form board.

Decoding experiments: E constructed a set of messages containing descriptions of such patterns which were then tape recorded and played to children in order to determine which (if any) factors in the encoding influenced the decodability of the message. The first few messages that E generated were only 5 (five) bit messages and although they were played to first graders, were found to be so easy that Ss made few errors (87% of the placements were correct). The messages were then expanded to 6 bits and the array was covered while the child listened and uncovered only after the message was completed.

Feedback experiments: The same "communication games" method was employed but this time with encoder-decoder dyads and a spatial-geometrical task of greater complexity was the transmitted information. This experiment shall not be described in the present report.

Experiment I:

This preliminary study (Gaite) was designed to indicate variability in adult encodings of a form board message for a hypothetical first grade audience. The encoders were a heterogeneous adult group of experimental and clinical psychologists, research assistants, secretaries and graduate students. These encodings were tape-recorded and transcribed. A casual inspection of these transcripts showed that they varied widely in informational adequacy, pre-structuring or rapport building, redundancy, pauses to allow for the child's presumed slower processing, and general "illocutionary force" or convincingness. As a summary index these messages differed widely in length of recording time, varying from 17 seconds to 4 minutes 40 seconds.

These messages also differed widely in their decodability by young children. Decodability was defined as the percentage of the correct form-board placements in the decoder's performance. By chance alone Ss would be expected to get 50% of the placements correct. For example, the two shortest messages and the two longest messages were played to first grade children. Table I

Insert Table I about here

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shows that for these extreme cases, the decodability was closely related to length of encoding.

It would be absurd, however, to think that message length per se is the critical factor. It suggests rather that adults do differ substantially in their style and effectiveness of encoding even simple messages for a hypothetical audience. Just what accounted for this variability becomes now a dominant question.

Experiment II:

One factor that undoubtedly accounts for part of the decodability of a message is its informational adequacy. The most obvious hypothesis to account for this critical difference is the level of intellectual development of the encoder. In a preliminary study (Marcus and Robinson) to test this factor, 18 children from each of the age levels, 3, 6, 9, and 12 attempted to encode a form board message (with a maximum of 4 bits of information required for an adequate description) to an imaginary friend over the telephone. While there was considerable difficulty in getting the younger children to comprehend the task requirements, the results as shown in Figure I are clearly as predicted. The

Insert Figure I about here

mean number of bits of information in the messages of the four age levels changed from 0 bits for the three-year-olds, to I bit for the six-year-olds, to 2 bits for the nine-year-olds to 4 bits (the maximum) for the twelve-year-olds. These differences are significant ($F = 25.4$, $p < .01$). Although the girls performed slightly better than the boys, this difference did not approach significance.

These data indicate that stage of intellectual development is an important determinant of the ability to generate an informationally adequate message. They have independent interest in that this method may be a good index of intellectual development; the number of bits they can encode in a message may correspond to the number of independent items of information they can simultaneously entertain conceptually, a hypothesis that may help explain the nature of conceptual development underlying the acquisition of conservation. This development has frequently been attributed to decreasing egocentrism but it also clearly reflects intellectual capacity (Cowan, Flavell). Further work would be required to show that the measures obtained by Marcus and Robinson are accurate.

While these preliminary experiments are clear in their demonstration of the fact that there is considerable variability in the encoding abilities and practice, we still have not considered what encoders can do to messages to make them more decodable. Consider now some of our preliminary efforts to assess some of these factors.

Experiment III:

The role informational adequacy in the decodability of a message requires no empirical demonstration. This experiment (Pagliuso and Olson) attempted to assess the effects of redundancy, pre-structuring, pauses for processing and pace on this decodability. 101 Toronto Grade I children served as subjects for the various parts of this experiment.

The general method of construction of these tape-recordings involved the construction of a basic message that contained the required information but which lacked any elaboration.

The simplest message recorded at conversational tempo that was informationally adequate but contained no elaborations was designated the Basic Message. Alternative tape messages were constructed by splicing in these types of elaborations, 1) pre-structuring - in which Ss were told the essential form of the message but without specifying any particular information, 2) redundancy - each half of the message was repeated and 3) pauses - after the first 4 bits of information, then after the next two bits the speaker paused to allow for the processing by the children. There were numerous illustrations of all three forms of elaboration in the original transcripts obtained from adults in Experiment I.

The strategy employed was to compare first the Basic Message to the one with all three types of elaboration (Fully Elaborated Message). Following this, if clear effects were found, it was proposed to examine these forms of elaboration separately. As will become clear in a moment, the effects of these factors combined was such that the tests for the effects of the more specific factors were not carried out.

Procedure

A crayon, cup, coin, box, pencil, and scissors were put out on the table. The subject entered and was seated facing E. Two warm-up problems were given by E, then the two problems on tape using these simple materials. Any errors made were pointed out to the S, and then the problem was repeated. The objects were then cleared from the table.

The form board and wooden pieces were then uncovered. To Ss in the BASIC MESSAGE GROUP, E said:

> You see all these pieces here? The tape will tell you what to do. You will have to remember because the pieces will be covered up. Remember which piece and where to put it.

To Ss in the ELABORATED MESSAGE GROUP, E said:

> You see all these things here? The tape will tell you about them. Listen.

The first part of the tape, the pre-structuring or task familiarization was then played. Ss were then told:

> The tape will tell you what to do. You have to remember because the pieces will be covered up. Remember which piece and where to put it.

For both groups the pieces and the board were then covered and the first problem played from the tape recorder. As soon as the message was completed, the materials were uncovered and the child chose the form and placed it in one of the four spaces (form and placement were recorded by E). Before each of the remaining three problems, the S was reminded to remember the piece and where it should go. The pieces were covered and uncovered as in Problem I.

Results and Discussion:

The children's mean performance on the Basic Message and the Fully Elaborated Message was almost identical, 70% correct as compared to 71% correct. From this, it appears that the three forms of elaboration, structuring, redundancy and pauses were unimportant to the decodability of the task.

However, upon closer examination, it becomes clear that the error patterns for the two groups have altered considerably (see Figure 2). The 70-71% error rates have been produced by quite different performances by the children. The factors in the Elaborated Message have influenced which "bits" of information have been decoded, while not affecting the total amount. This analysis of variance is presented in Table 2. This table shows that while there is no

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Insert Table 2 about here

Insert Figure 2 about here

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significant difference between the messages, there is a significant difference between message bits (dimensions) and an interaction between these message components and the message type. The nature of this interaction is illustrated in Figure 2. The first three bits of information are decoded better in the Basic Message, the fourth is at a cross-over point and the last two bits of information are processed better in the Fully Elaborated Message.

It is possible to make some hypothesis about why these Elaborations fail to have an overall effect on the decodability of the messages. The simplest one is that these elaborations essentially cancel each other out. This seems unlikely in that the Elaborations did have an effect on several items but not on the message as a whole. A more compelling hypothesis is that the lack of an overall effect is a function of the type of materials that have been employed in this study. The information that the child has to store and recall is in the form of independent, binary bits that cannot be re-coded into larger informational "chunks" to use George Miller's description. The net result of this is that the information that is processed is a function of the limitations of short term memory. Since there is a low limit on what they can store and retrieve (4 to 6 digits), if one bit is added or inserted into the limited memory span by such means as stress or repetition or the Elaborations we have employed here, it enters at the expense of one of the bits already there. Hence, the number of bits decoded remains constant while the Elaborations in the message determine which of the bits are retained in short term memory.

If in this case it is the child's limited short-term memory that puts a ceiling on the child's decoding of these messages, the teacher encoder's role in facilitating the transmission of messages is obviously restricted. Presumably there is nothing the teacher or encoder can do to increase the number of bits processed and recalled by the decoder. However, a good encoder teacher knows this; the teacher's alternative is to so present the information that the child's limited memory span is not exceeded. He does this by breaking the messages into components of processable length and then lets the child process one component before proceeding to the next one. This is what, in fact, the majority of our original adult encoders (Experiment I) have done, primarily through their use of pauses.

The next step is to verify that this is an appropriate and effective way to increase the decodability of these messages.

Experiment IV:

The procedure employed in this experiment was identical to that employed with the Elaborated Message groups in Experiment III, both in the warm-up problems and in the tape-recorded messages. The only modification was that the array of wooden forms to be placed was left uncovered, while the child listened to the messages. Twenty Ss were randomly assigned to this group at the same time and from the same population as the Ss in Experiment III, thus assuring their comparability to those groups.

Procedure:

The form board and pieces were uncovered after the warm-up problems were completed. S was told:

> You see all these things here? The tape will tell you about them. Listen.

The first part of the tape, pre-structuring or task familiarization, was played. S was then told:

> The tape will tell you what to do. Remember which piece and where to put it. Don't begin until I stop the tape. Listen to it first.

S listened to the first problem, then chose the form and placed it. The remaining three problems were given in the same manner. S's performance was recorded.

Results and Discussion:

As was predicted, this arrangement permitted an increase in the decodability of the message. When the uncovered or visible array of forms was employed, the children's performance improved to 89% correct compared to 71% when the array remained covered (Experiment III). The summary of the analysis of variance of these results is presented in Table 3. This table shows that these differences

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Insert Table 3 about here

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are significant beyond the .01 level.

The visible array combined with the Elaborated Message permitted the child to listen to the first component of the message which was within his memory span, process this information and visually select the corresponding form. This operation had the effect of emptying the short term memory storage space so that the child could then listen to the second part of the message and decode it. The net effect was a substantial increase in the children's success in decoding the message.

Under some conditions, the child may be able to process the incoming information at the same time as he is responding to the earlier components of the message in a manner similar to that involved in decoding ordinary connected discourse. This is particularly likely if the information is presented somewhat more slowly than ordinary conversation. This is illustrated by the following simple experiment.

Experiment V:

Two 5 bit Basic Messages were constructed which were informationally identical but in one case spoken at a normal conversational tempo (Conversational), and in the other spoken at a tempo that E intuitively judged as appropriate for speaking such a message to young children (Instructional). Following up a warm-up session, these tapes were played to 24 Grade I children, 12 children per group.

Their performance in the first case, Conversational Tempo, was 76% correct while the performance of the second group, Instructional Tempo, was 87% correct, a difference significant at the .05 level. From this we conclude that if information is presented at an appropriate tempo, processing can occur while new information is coming in without making special allowances of pauses for that processing. It also shows that one can intuitively judge how information should be presented to the child. E formulated no particular plan as to how to deliver the message to the child except that the child would be required to comprehend and respond to the message; that in itself was sufficient to modify the ordinary speech so as to make the message more comprehensible by the young child. This is a reflection of the ordinary observation that when one is attempting to transmit more complex information, one speaks more slowly.

Conclusions and Implications:

These preliminary efforts to determine some of the factors that determine the effectiveness of communication, both in the encoding and the decoding phases, have shown that while the problem is amenable to empirical investigation, the findings thus far do not go substantially beyond what one already intuitively knows. One limiting factor in this work has been the tasks employed in the communication experiments. While the materials have the advantage of being binary and hence measurable in terms of information theory, they have the disadvantage that with each material there is little that an imaginative teacher-encoder can do with material to make it more easily comprehended or followed. We feel forced, therefore, to move to more complex material.

The results thus far have been sufficiently encouraging to warrent further studies, two of which are currently in progress. The first of these (W. Wine) is an empirical test of the effects of feedback from the listener on the encoding and subsequent decoding of a set of messages concerning the drawing of a series of connected rectangles, a Spatial-Geometric task. Preliminary results indicate that the efficiency of the communication is a direct function of the degree of feedback permitted (within the narrow range permitted in this experiment) and that the visual and auditory components of the feedback appear to be additive.

The other (Olson and Crossan) involves for the first time actual experienced teachers communicating both the Spatial-Geometric messages described above as well as a Verbal List message to Senior High School and to Grade V children again in a dyadic situation, with no feedback permitted. We hope to identify the generality of encoding ability both in terms of different decoding populations and different content (Verbal as opposed to Geometric), and by means of a linear regression analysis to identify a set of independent variables, such as academic background, teaching experience, intelligence, conceptual level, intelligence of the decoder, that accounts for the success of the communication, (i.e., the decodability of the messages). No analysis of this data has yet begun but it appears that most of our teachers are guilty of "over-kill", our decoders are more bored than frustrated.

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Table 1

Encoding Variability and Message Decodability

Encoding		Decoding	
Encoder	Message Length	N	Mean % Correct
A	17 sec.		36%
B	1 min. 5 sec.		69%
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Y	2 min. 25 sec.		78%
Z	4 min. 40 sec.		88%

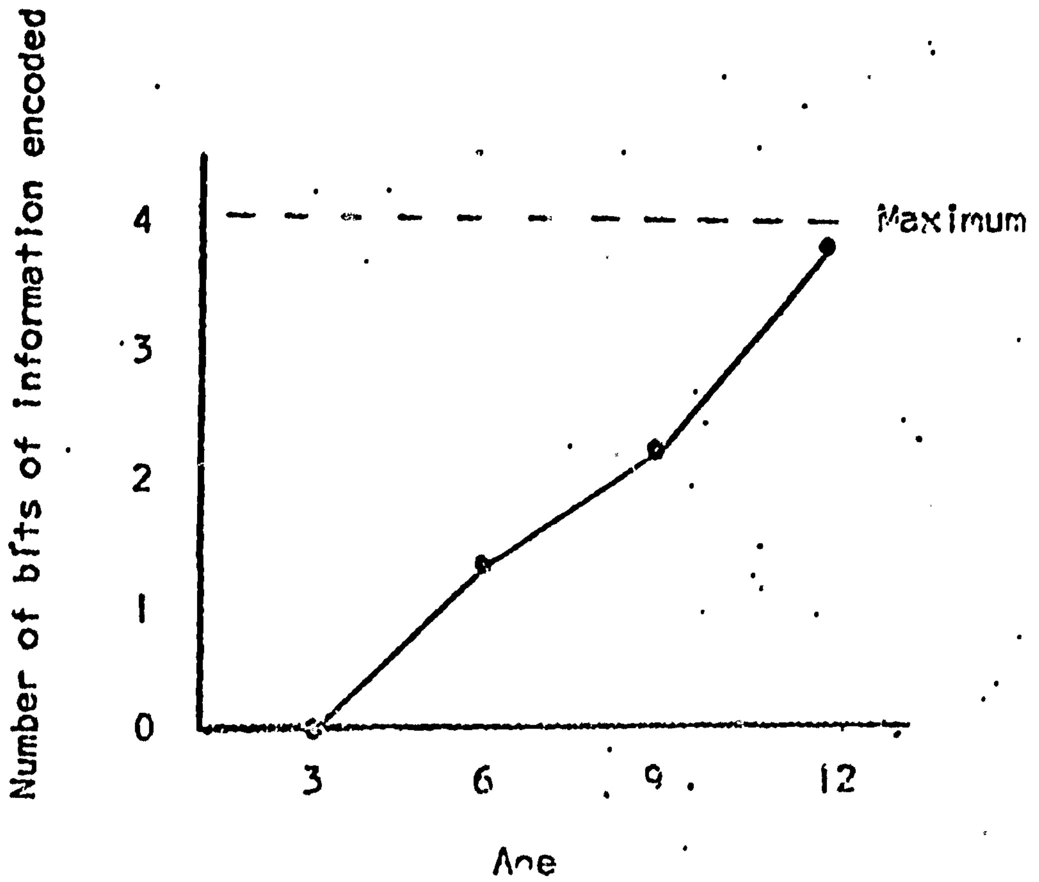

Figure 1. Encoding ability of children measured by bits of information in a message.

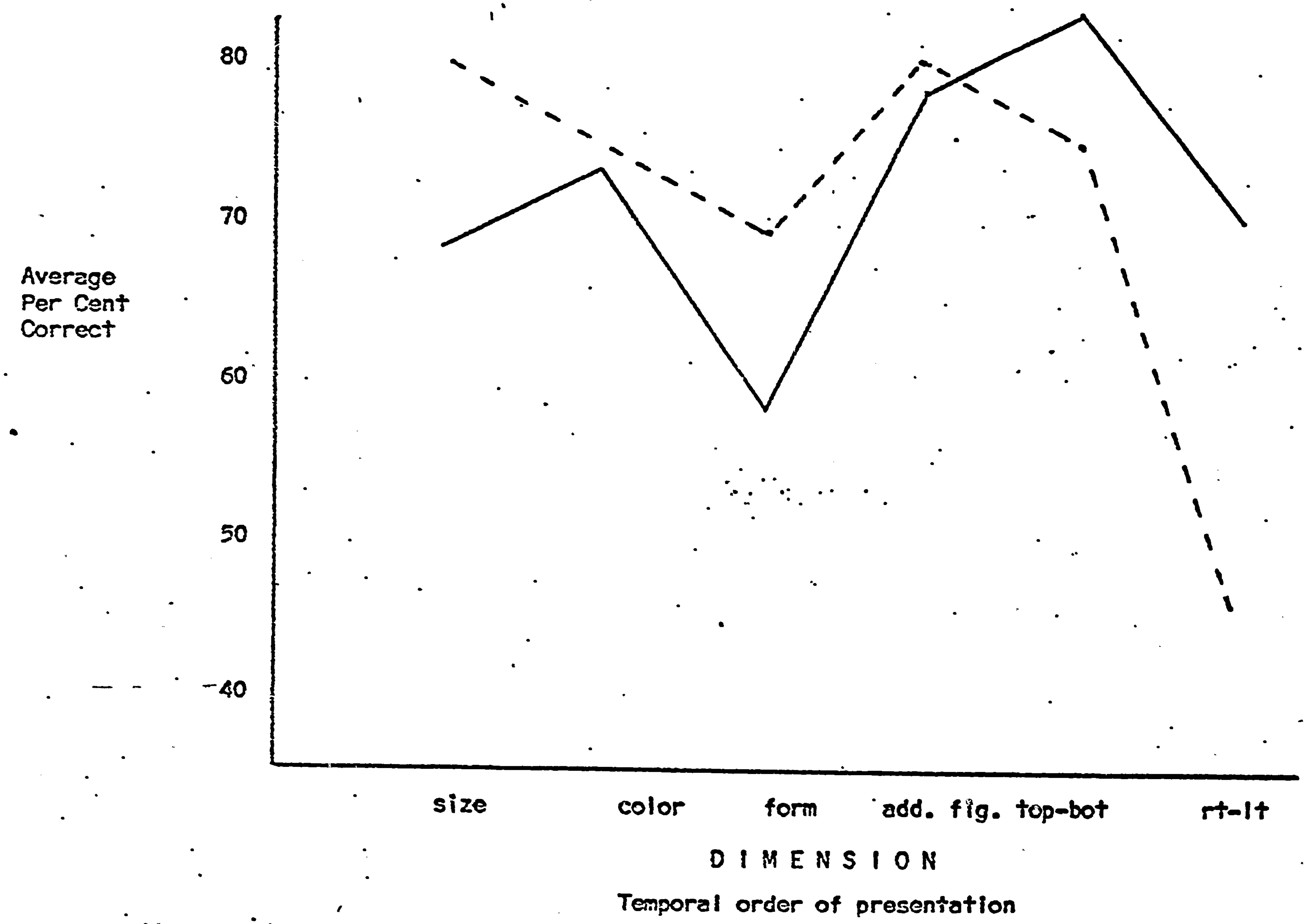

Figure 2. Per Cent Correct Over 4 Problems In Order of Presentation on Tape for Basic Added Covered and Full Added Covered Messages (N = 20/grp)

redundancy augments primacy effect.

Table 2

Analysis of Variance for Correctness
on Dimensions (4 prob/S) for Basic Added Covered Message
and Full Added Covered Message

Source of Variation	SS	df	MS	F
Between Subjects	55.47	39		
A (Message)	.11	1	.11	.08
Ss within Groups	55.36	38	1.46	
Within Subjects	229.83	200		
B (Dimension)	25.93	5	5.19	5.35*
AB	19.21	5	3.84	3.96*
B x S within Groups	184.69	190	.97	

*sig .01

Table 3

Analysis of Variance for Correctness over 4 Problems for Full Added Uncovered and Full Added Covered Messages (N=20/grp)

Source of Variation	SS	df	MS	F
Between Methods	3222.1	1	3222.1	28.26*
Experimental Error	4333.7	38	114.0	

*sig .01